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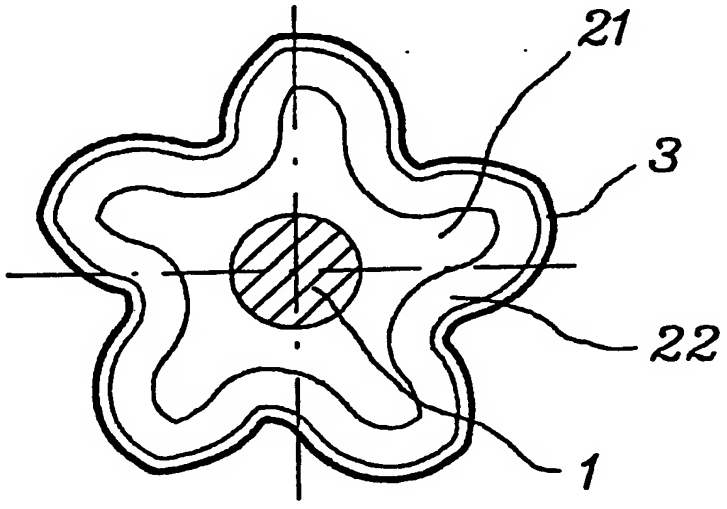
(54) Title: A METHOD FOR MANUFACTURING SCREW ROTORS



(57) Abstract

The invention relates to a method of manufacturing rotors of the kind having helical lands and intermediate grooves. A rotor body (2) is moulded or formed in some other way on a shaft (1) to only a small degree of accuracy, whereafter an outer layer (3) of polymer-based material is moulded on the rotor body to a high degree of accuracy. For the purpose of eliminating shrinkage-induced distortion of the lands of the rotor body (2) subsequent to applying the outer layer, the rotor body is produced in a multiple of layers (21, 22), by casting or like moulding processes, with each of said body layers having a thickness which is greater than that of the outer layer (3).

A METHOD FOR MANUFACTURING SCREW ROTORS

The present invention relates to a method for manufacturing helical screw rotors in accordance with the preamble of claim 1. The invention also relates to rotors manufactured in accordance with the method.

Normally, helical screw rotors are machined from solid metal blanks. Moreover, the rotors have a complicated geometric shape, which places great demand on accuracy in manufacture. Machining of the rotors from solid rotor blanks also involves the removal of large quantities of material from the blank. All of which results in long manufacturing times and high production costs.

Consequently, there has long been a demand for a simpler method for the manufacture of helical screw rotors, without the need to observe such high precision in manufacture, such that rotors of this kind can be produced in large numbers at reasonable cost.

Swedish Patent Applicatin No. 8603720-7 and PCT/SE87/00397 teach a number of known methods for the manufacture of helical screw rotors, in which manufacture is simplified by moulding a plastic surface layer onto a plastic or a metal rotor body, which in turn is mounted on a metal shaft. These konwn methods are based on the concept of first producing a rotor body with no particular attention to measurement accuracies, and then moulding onto the body a surface layer formed to exact measurements. The desired result is normally achieved, when the rotor body is made of metal. Although plastic-moulded rotor bodies represent a considerable simplification in the manufacture of such bodies, subsequent shrinkage of the plastics material creates drawbacks which are not found when casting or moulding other kinds of plastic objects, where sub-

sequent shrinkage of the plastics material can be anticipated and compensated for. The particular difficulties which manifest when moulding helical screw rotors relate to the helically extending cams, which as a result of the shrinkage become distorted in a manner which cannot readily be calculated prior to manufacture. This distortion changes the pitch of the cams in the vicinity of the ends thereof.

The effect of this shrinkage-induced distortion can be eliminated in some cases, by imparting to the thin-wall lands or threads of female rotors a degree of elasticity which will allow the lands to be deformed elastically in operation. This feature will also afford certain advantages, as reported in PCT/SE86/00109.

Another solution must be found, however, in the case of male rotors and female rotors of larger land-wall thicknesses.

This solution is provided by the present invention, according to which the rotor body is moulded, injection moulded, etc., from several layers of solidifying material, suitably a material composite, such as to allow especially shrinkage-induced distortion of the lands or threads to be eliminated, by application of the outer layer. The degree of distortion and measurement deviations which remain despite moulding the rotor body in several layers will not be so great as to prevent the distortion and measurement deviations from being eliminated, by moulding the outer layer of polymer-based material onto the rotor body, which layer can then be made relatively thin and consequently will have negligible shrinkage.

The rotor body can be moulded in accordance with one of a number of different methods, including sintering, using many different kinds of material, as defined in claims 2 to 7. All of the layers of the rotor body will preferably be made from a polymer-based material, suitably a material composite, i.e. a material reinforced with fibres in accordance with known techniques.

The invention will now be described in more detail with reference to an exemplifying embodiment thereof illustrated in the accompanying drawing, in which Figure 1 illustrates in axial section the top half of a rotor manufactured in accordance with the invention, and Figure 2 is a sectional view taken on the line II-II in Figure 1.

The illustrated rotor, which is a male rotor, includes a shaft 1, which may be made of steel or a reinforced plastics material of extremely high bending strength, and a rotor body 2 which has moulded thereon an outer layer 3 of polymer-based material. The illustrated rotor body 2 comprises two body layers 21, 22 of polymer-based material, of which the innermost body layer 21 is somewhat thicker than the outermost layer 22. Shrinkage of the body layer 21 shall have terminated, before moulding of the outer layer 22 is complete. Similarly, shrinkage of the outermost of said two body layers shall have terminated, prior to moulding of the thin outer layer 3 being completed, therewith to achieve the highest possible measurement accuracy and the least possible distortion of the rotor lands, in the simplest possible manner.

To ensure uniform solidification of the rotor body, the thickness of each layer will preferably be as uniform as possible. The shaft embodiment with helical lands or threads described in the aforesaid PCT/SE86/00109 can be used to this end, and when different materials are used, the thermal coefficient of expansion of the layers should be so selected in respect of the material of adjacent layers and the material of the shaft and the outer layer 3 as to ensure that the smallest possible differences in thermal expansion are obtained.

In the case of the preferred embodiment, the shaft 1 is made of steel which has a thermal coefficient of expansion of $\alpha = 12 \times 10^{-6}$ m/m/^{o}K, the layer 21 is made of polyetherimide with a 30 % glass-reinforcement. ULTEM 2300® (General Electric) with a density of 1.51 g/cm^3, a bending

modulus of 9000 N/mm^2, α = 20 x 10^{-6} m/m/^{o}K, the layer 22 is made of a polyetherimide ULTEM 2100® with a 10 % glass-reinforcement, density 1.34, bending modulus 4500 N/mm^2, and α = 32 x 10^{-6}. The outer layer 3 consists solely of polytetraflouroethene plastic (Teflon®) and varies in thickness from about 1/100 mm to 1-2 mm depending on the extent of subsequent shrinkage of the rotor body, prior to moulding of the outer layer 3 being completed.

It will be understood that the invention is not restricted to the described and illustrated embodiment thereof and that many modifications are possible within the scope of the inventive concept defined in the following claims. For instance, the various layers may include particles of metal and or ceramic material, in addition to reinforcement fibres of greater or smaller lengths. At least one of the outer layers of the rotor body may comprise a porous plastic material, in which case the density will preferably increase in a direction towards the two faces of the layer.

CLAIMS

1. A method for manufacturing rotors which have helical lands with intermediate grooves and which comprise a carrier shaft (1) having a rotor body (2) mounted thereon, and an outer layer (3) of polymer-based material applied with great measurement accuracy on the rotor body, said rotors being intended for use in screw rotor machines, c h a r a c t e r i z e d in that the rotor body is manufactured by casting, moulding, jet moulding or likewise moulding the body from a multiple of body layers (21, 22) of solidifying material, suitably a material composite, such as to enable particularly shrinkage-induced distortion of the lands during solidification of the material to be eliminated by application of the outer layer (3).

2. A method according to claim 1, c h a r a c - t e r i z e d by forming all of the layers (21, 22) of the rotor body from polymer-based material.

3. A method according to claim 1, c h a r a c - t e r i z e d by producing at least one of the layers of the rotor body by sintering.

4. A method according to claim 1 or claim 2, c h a r a c - t e r i z e d by incorporating a ceramic material in at least one of the layers of the rotor body.

5. A method according to claim 1 or claim 2, c h a r a c - t e r i z e d by forming at least one of the layers of the rotor body from a porous material and by giving the layer a density which increases outwardly from within.

6. A method according to any one of claims 1 to 5, c h a r a c t e r i z e d in that the thickness of the layers of the rotor body decreases outwardly from within.

7. A method according to any one of claims 1 to 6, c h a r a c t e r i z e d in that the outer layer is given a smaller thickness than any of the layers of the rotor body.

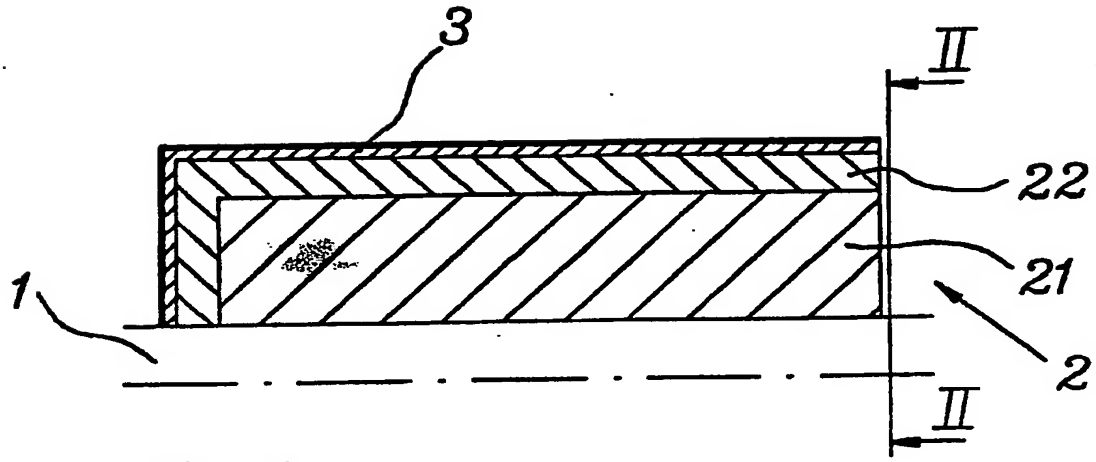


Fig. 1

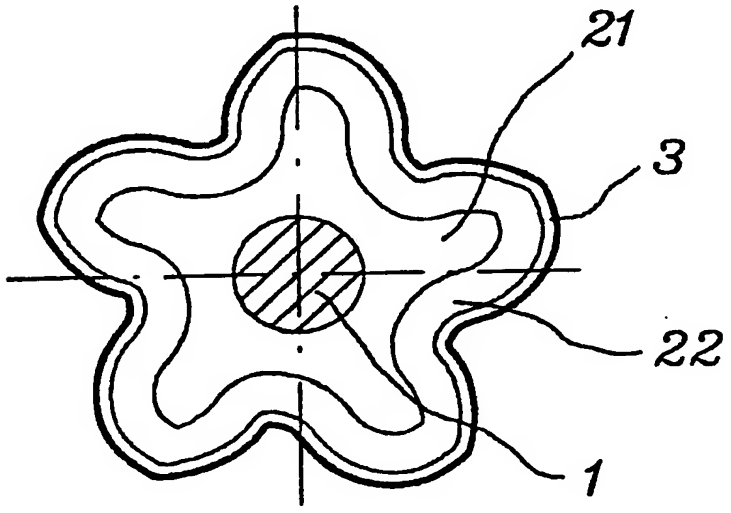


Fig. 2

INTERNATIONAL SEARCH REPORT

International Application No PCT/SE89/00173

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC 4

F 04 C 18/16

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC 4	F 04 C F 01 C

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched [8]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
Y	US, A, 2 519 588 (R P McCULLOCH) 22 August 1950	1
Y	Patent Abstract of Japan, Vol 7, No 287, M264, abstract of JP 57-42743, published 1983-09-24	1
Y	US, A, 3 841 805 (ZALIS) 15 October 1974	1
Y	DE, A, 1 944 942 (JOY MANUFACTURING COMPANY) 12 March 1970 & US, 3535057 GB, 1276348	1

* Special categories of cited documents: [14]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
1989-05-30	1989 -06- 15
International Searching Authority	**Signature of Authorized Officer**
Swedish Patent Office	Nils-Ivar Tjernberg